

A Laboratory Examination of Substrate, Water Velocity, River Morphology, and River Training Structure Preference by Juvenile Pallid (*Scaphirhynchus albus*) and Shovelnose (*Scaphirhynchus platorynchus*) Sturgeons

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Introduction

The pallid sturgeon (*Scaphirhynchus albus*) may be close to extinction, which prompted the U.S. Fish and Wildlife Service to list them as an endangered species in 1990 pursuant to the Endangered Species Act of 1973 as amended (USOFR 1990). Historically, the range of pallid sturgeon encompassed the Yellowstone River from the Bighorn River to the Missouri River; the Missouri River from Great Falls, Montana to the Mississippi River; and the Mississippi River from the Missouri River to the Gulf of Mexico (Bailey and Cross 1954, National Paddlefish and Sturgeon Steering Committee 1992, USACE 1993). Forbes and Richardson (1905) and Bailey and Cross (1954) suggest that pallid sturgeon were never common. However, since construction of dams and reservoirs on the Missouri River, further decline of the species has become apparent and only remnant populations remain (National Paddlefish and Sturgeon Steering Committee 1992). Because pallid sturgeon are so rare, little is known about their life history and habitat requirements. Adult pallid sturgeon, like shovelnose sturgeon, inhabit comparatively large flowing rivers, but pallid sturgeon occur over a narrower range of conditions. They are postulated to prefer greater turbidity (Bailey and Cross 1954, Lee 1980a, 1980b), finer substrates, and deeper, wider channels; and they are more likely than shovelnose sturgeon to occur in sinuous reaches and near long-established islands and alluvial bars (Bramblett 1996). Despite intense sampling efforts by fisheries personnel (Clancey 1991, Hrabik pers comm., Krentz pers comm.), field collections of young sturgeons are rare. Consequently, the microhabitat used by juvenile pallid sturgeons has not been described, and little is known about the habitat requirements and ecology of any young North American sturgeon species (Chan et al. 1997). The acquisition of sound scientific information on life history and habitat requirements of all life stages was deemed essential to the formulation of recovery and management plans for the pallid sturgeon (Kallemeyn 1983, USFWS 1993).

Unfortunately, the difficulties of studying the life history and population dynamics of sturgeon in the field are enormous (Ragotzkie 1985, Gilbraith et al. 1988). Parsley et al., (1993) suggest that additional information on juvenile sturgeon habitat preferences for velocities and substrates may best be obtained through laboratory studies, while Chan et al. (1997) propose that laboratory studies of microhabitat selection should be carried out to identify habitat critical for the recovery and management of sturgeon species until appropriate field studies can be executed. Thus, we propose to conduct a laboratory study to investigate the influence of water velocity, substrate, river morphology, and river training structures on the habitat selection of juvenile pallid sturgeon. We will examine habitat selection in pallid and shovelnose individuals, as well as intra- and inter-specific groups, since both intra- and inter-specific dynamics may influence habitat selection (Matheson and Brooks 1983). Protection of endangered species must involve identifying their essential habitat requirements. Only then can an attempt be made to protect the remaining natural habitat or to restore or develop new areas of suitable habitat.

Methods and Materials

Flume Design

An 18,927 l (5000 gal) elliptical flume (Figures 1 and 2) will be used in the laboratory to quantify the distribution of individuals and groups of pallid (*Scaphirhynchus albus*) and shovelnose (*Scaphirhynchus platyrhynchus*) sturgeons in relation to water velocity, substrate type, river morphology and river training structures at room temperature (21-22°C; 70-72°F) between 0700 and 1600 hours. The experimental flume consists of a 16 cm (6") thick concrete bottom with 2 cm (3/4") plywood sides supported by a 5 x 10 cm (2" X 4") wooden frame. The perimeter of the flume is also supported by a raised flooring system. The flume is lined with 45 mil Firestone PondGuard (Ethylene Propylene Diene Monomer) and underlain with Geo-Pad, a polypropylene nonwoven needlepunched fabric (www.pondsuppliesrus.com). A 13 cm (5") deep layer of clean sand lines the flume bottom. Clean gravel will be used to construct islands and point bars.

Water filtration and circulation will be accomplished using a 4000 gallon per hour (gph) wet/dry Green Machine mechanical and biological canister filter (GM6000; www.pondsuppliesrus.com) supplied with an in-line 1/8 horse power (hp) PerformancePro Artesian pump (A1/8-35; www.pondsuppliesrus.com). The water intakes and outtakes of the filtration system will be designed to distribute flow proportionally over the entire flume. Twenty to 40 submersible power heads (Hagen) suspended from overhead braces will be used to increase water velocity.

Experimental Design

Organisms experience the environment in terms of a combination of features simultaneously. In order to determine the water velocity, substrate type, river morphology, and river training structure inclinations of pallid and shovelnose sturgeons, 50-100 (total) replicates of the following experiment will be conducted using (1) an individual pallid sturgeon, (2) a group of six pallid sturgeons, (3) an individual shovelnose sturgeon, (4) a group of six pallid sturgeons, and (5) a mixed species group of three pallid and three shovelnose sturgeons. The sturgeon(s) will be placed in the flume and allowed to acclimate for 20 minutes (Chan et al. 1997). Following the acclimation period, the specific location of each individual will be recorded every 10 minutes for a period of three hours (19 point samples per individual). Individuals will not be disturbed during the sampling period.

The flume substrate will consist primarily of sand, with the exception of gravel islands and point bars. River morphology including main channel, main channel border, side channel, and scour holes will be present. River structures such as stone dikes, weirs, islands, point bars, chevrons, and woody structure will also be included in the flume design. Thus, habitats available for selection will include (1) gravel island, (2) gravel point bar, (3) sand main channel, (4) sand main channel border, (5) sand side channel, (6) sand scour hole, (7) sand stone dike, (8) sand weir, (9) sand island, (10) sand point bar, (11) sand chevron, (12) sand woody structure, (13) sand only.

Water velocity

Water velocity will range from 0-120 cm/s, and will be measured as a quantitative variable using a SonTek/YSI FlowTracker Handheld ADV (Acoustic Doppler Velocity meter). The device takes velocity readings at a single point if the velocity is within the range of 0.001 m/s (0.1 cm/s, 0.003 ft/s) to 5m/s (500 cm/s, 16 ft/s). Measurements are stored in a hand-held interface with real-time velocity display. Measurements are then uploaded into a PC for analysis. (<http://www.sontek.com/product/flowtracker/flowtracker-ov.htm>).

Grid system

A reference grid will be used to plot the location of individuals in the flume. The grid consists of a geo-referenced coordinate system established by a surveying method. Once the geo-referenced axis is determined, incremental measurements of 10 cm (3.9 in) will be marked on the rails of the flume to assist in determining the x and y-coordinates. The z-coordinate will be determined with a surveying rod.

Bathymetry

Bathymetry will be plotted using the above mentioned surveying method. The grid placed on the rails of the flume will be utilized to establish survey lines. The bathymetry will be measured by placing the surveying rod along the bed at set intervals and recording the readings. The number of intervals necessary will be determined by visually examining the complexity of the flume bed and increasing the measurements taken in areas of increased complexity.

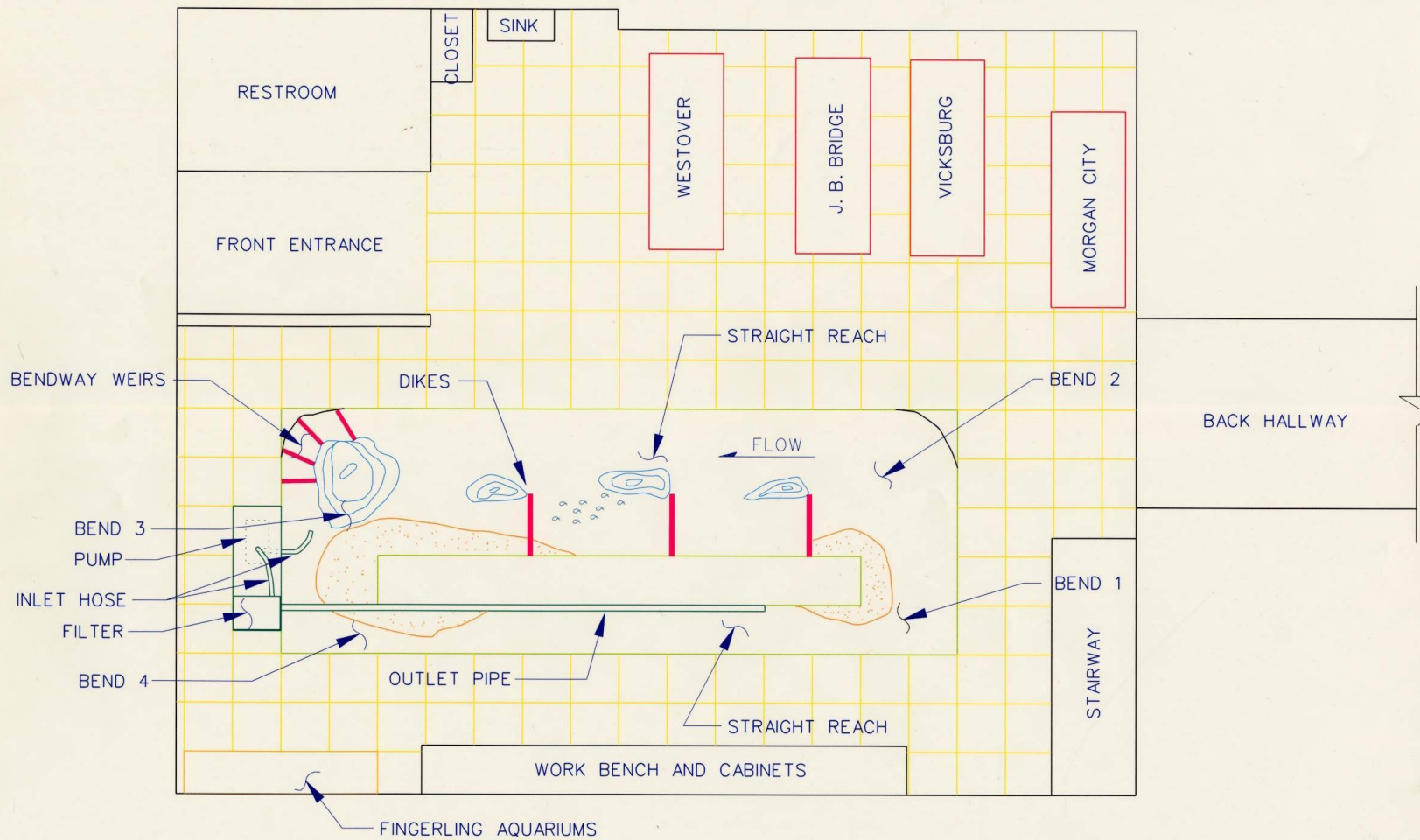
Data Analyses

The data are treated as responses (numbers of fish) distributed across response levels (different velocity and habitat types) according to a multinomial distribution. For response data having a normal distribution, regression models containing combinations of fixed and random effects will be used. These are called "mixed" models. These models assume a data structure in which observations having a common characteristic form identifiable groups (e.g., experiments) resulting in nesting of the observations. The data to be obtained here consist of counts of fish occupying each habitat. Analyses based on the normal distribution may be asymptotically appropriate under some circumstances, but the assumption of asymptotic normality is not appropriate in these experiments, where the number of fish per experiment will be small.

For count data with a binary response (e.g., a single habitat which is either occupied or not occupied), cluster-correlated logistic regression will be used. The methods used for binary responses will be extended to the type of data of concern here, count data from a multinomial distribution. The data will be analyzed using an extension of logistic regression that uses generalized estimating equations (GEE) rather than normal distribution theory. SUDAAN version 8.0 (Research Triangle Institute), a program that implements the GEE algorithm for analyzing the multinomial logistic model, will be used.

Significance

The use of artificial stream systems in experimental ecology has recently been reviewed (Lamberti and Steinman 1993). They suggest that one of the most useful applications of artificial streams is the development of hypotheses which can later be tested in the field. The artificial stream system can be used to experimentally determine the preferences of riverine fishes. These preferences can be used to predict both distributions and habitat alteration impacts in rivers. This can be verified by field ecological studies (Palmer and Goetsch 1997). Ultimately, the protection and re-establishment of endangered species must involve identifying essential habitats for all life stages. Only then can an attempt be made to protect the remaining critical natural habitats, and to restore or develop new areas of suitable habitat.



PALLID STURGEON STUDY



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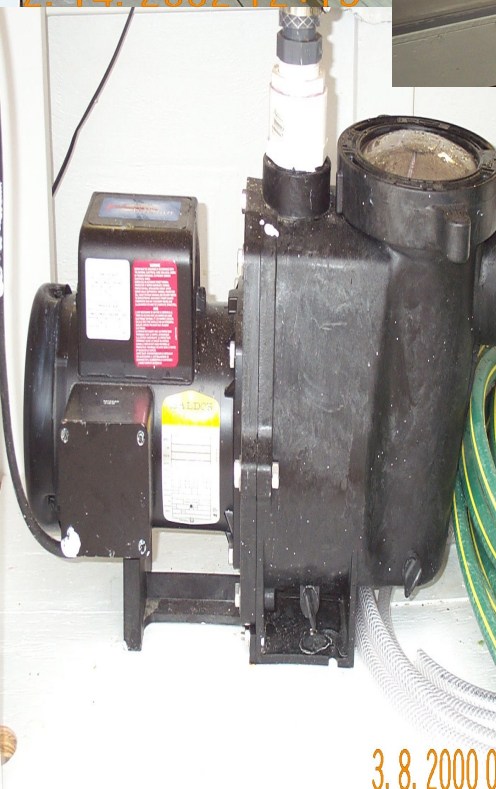
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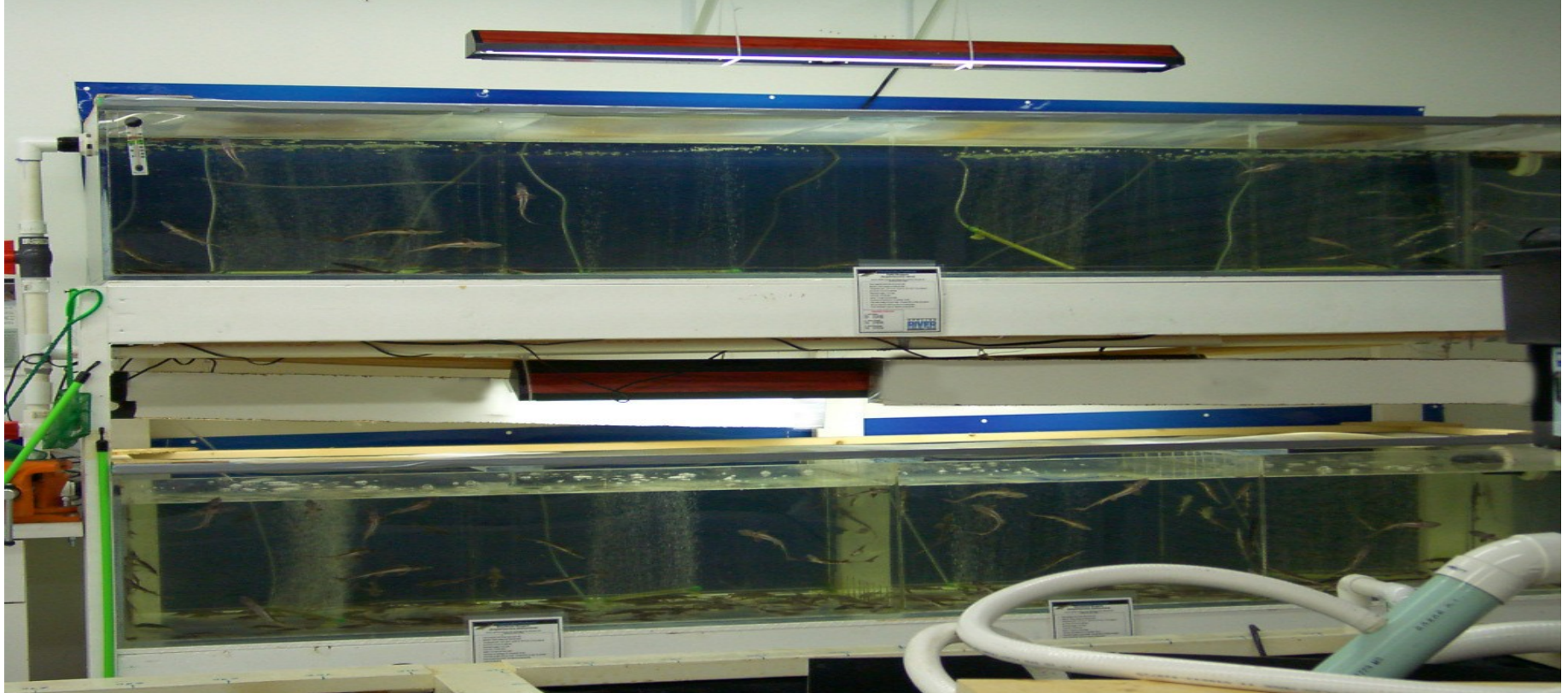
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Pallid Sturgeon

- outer barbels past mouth
- inner barbels above outer barbels
- longer snout



Shovelnose Sturgeon

- outer barbels not past mouth
- inner and outer barbels attached in a line
- shorter snout



